The study of the origin of the fish groups of Japan affords a fascinating index to its multifarious problems.

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## THE LABORATORY TEACHING OF PHYSIOLOGY.*

THE student of physiology should perform the classical experiments upon which the science rests. The writer of these papers has for several years endeavored to place the laboratory teaching of physiology within the reach of every school. To accomplish this it is necessary that apparatus of precision be designed upon lines permitting its manufacture in large quantities at a small cost. The apparatus described below is believed to show progress in this direction.

### I. THE ARTIFICIAL EYE.

The artificial eye (shown in section in Fig. 1, one fourth the actual size) consists of a wooden box the top of which is closed by laying upon it a piece of clear plate-glass. A circular opening in the front of the box admits the rays from a lantern or other source of light. This circular window may be closed by a clear glass plate or by any of the several diaphragms described below. Two pins, one at the side and one below the opening, are so placed that when the diaphragm rests against them its aperture will lie in the axis of the optical system. The lenses and mirrors employed with the box are mounted in square wooden blocks, to protect them from injury. When the side of the wooden block is placed against the 'rabbit strip' shown at the lower inside angle of the box the center of the lens or mirror mounted in the block will lie in the optical axis. The rays of light entering the box are made visible by the fumes of Japanese incense, a small stick of which is lighted and placed in a hole in a cork upon which fits a tin cylinder shown in Fig. 1.

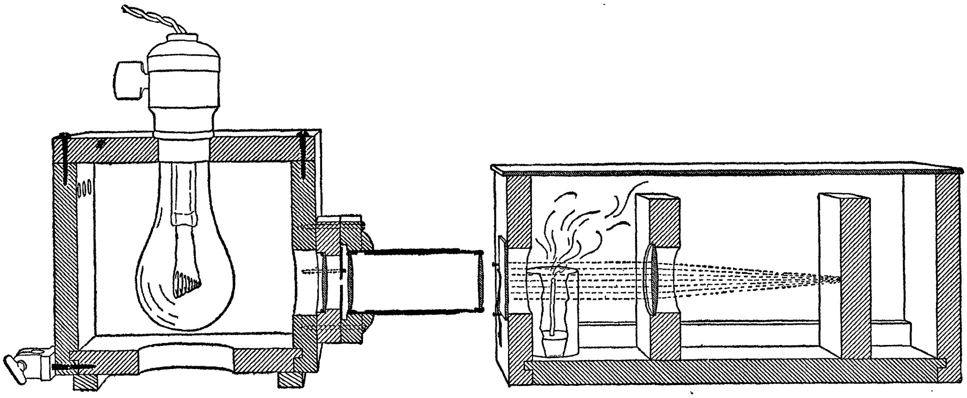

FIG. 1. The optical lantern and artificial eye.

The optical lantern consists of a sixteen-candle-power electric lamp, with small spiral filament, mounted in a wooden box pierced with holes which permit thorough ventilation but do not allow the escape of light to disturb the observer. The lantern box is provided with a condensing lens and two focusing lenses mounted in draw tubes which may be easily removed. The slot for the diaphragms is furnished with a stop so placed that when the diaphragm is shoved against it the aperture of the

* Porter, W. T.: *Boston Medical and Surgical Journal*, Dec. 29, 1898. *Philadelphia Medical Journal*, Sept. 1, 1900. 'An Introduction to Physiology,' Cambridge, 1900 and 1901. 'Experiments for Students in the Harvard Medical School,' Second Series, Cambridge, Jan., 1901. Third Series, Cambridge, May 1901.

diaphragm will lie in the optical axis. When the focusing tubes are removed the lantern may be mounted on a stand by means of a brass ring with set screws, and then serves admirably for ophthalmoscopic or laryngological work.

The following lenses, diaphragms, etc., are provided for the experiments in physiological optics made by first-year students in the Harvard Medical School. Convex lens, four inches focus; convex lens, twenty inches focus; concave lens, twenty inches focus; astigmatic cylinder, twenty inches focus; astigmatic cylinder, five and a half inches focus; mirror, convex on one side, concave on other, one inch focus; plain mirror; diaphragm with circular aperture two millimeters in diameter; diaphragm with vertical and horizontal slits; diaphragm with L-shaped slit; clear-glass slide; ground-glass slide; wooden screen to serve as retina; square bottle filled with eosin solution, to study refraction.

With this apparatus reflection and refraction from plain and spherical surfaces, spherical and chromatic aberration, astigmatism, myopia, and hypermetropia may be studied. A special dark room is not necessary. The light rays are very distinct in any room after sunset. A hundred or more students may work in the same laboratory. If a focusing-cloth or other screen be used, the observations may be made in daylight.

### II. THE CIRCULATION SCHEME.

The artificial scheme (Fig. 2) to illustrate the mechanics of the circulation in the highest vertebrates consists of a pump, a system of elastic tubes, and a peripheral resistance. The inlet and outlet tubes of the pump are furnished with valves that permit a flow in one direction only. The peripheral resistance is the friction which the liquid undergoes in flowing through the minute channels of a piece of bamboo. To this must be added the slighter resistance due to friction in the rubber and glass tubes.

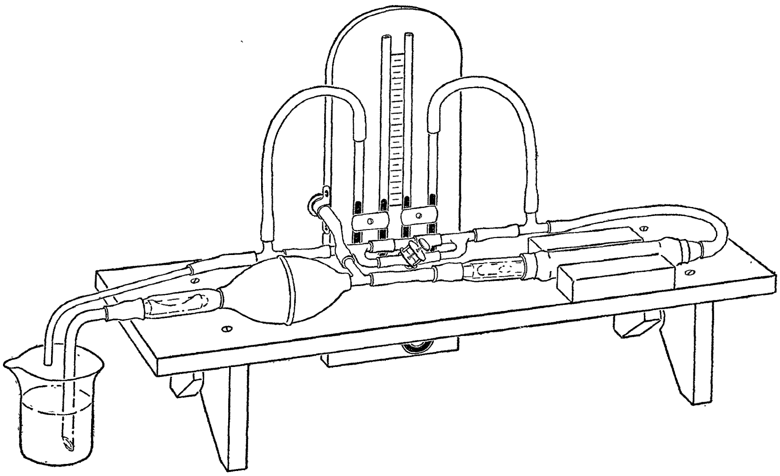

FIG. 2. The circulating scheme.

In this system the pump represents the left ventricle; the valves in the inlet and outlet tubes the mitral and aortic valves, respectively; the resistance of the channels in the bamboo the resistance of the small arteries and capillaries. The tubes between the pump and the resistance are the arte-

ries; those on the distal side of the resistance are the veins. The side branch substitutes a wide channel for the narrow ones and thus is equivalent to a dilatation of the vessels. Between the pump and the outlet valve is a side tube leading to a membrane manometer which records the changes in the pressure within the pump (the loss in conveying the pressure through the short wide connecting tubes may be neglected). A mercury manometer is placed between the pump and the capillary resistance, to measure the arterial pressure, and a second mercury manometer on the distal side of the capillary resistance to measure the venous pressure.

The device used for the aortic valve is shown in Fig. 3. A small glass tube is fastened in a larger glass tube by a collar of rubber tubing. The small glass tube is closed at one end. One side is pierced with a valve hole. The valve hole is closed by a piece of rubber tubing which is drawn over the small glass tube, and the middle portion of the rubber tubing is cut away

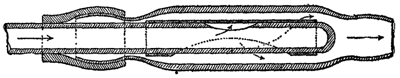

FIG. 3. The modified Williams' valve of the circulating scheme.

except over the hole. During the stroke of the pump the water enters the small glass tube under pressure, lifts the rubber, escapes through the valve hole, and is carried off by the large glass tube. When the pressure in the small glass tube is no longer as great as that in the surrounding large glass tube the rubber shuts the valve-hole. Backflow is thus prevented. The mitral valve is similar to the aortic, but the position of the small glass tube is reversed.

With this apparatus the physical phenomena of the circulation may be learned thoroughly. The conversion of the intermittent into a continuous flow, the relation between rate of flow and width of bed, the relation of peripheral resistance to blood-pressure, the inhibition of the ventricle, the opening and closing of the aortic valve, the period of outflow from the ventricle, the pulse wave, the physical phenomena of the circulation in fevers and in aortic and mitral regurgitation and stenosis, may all be studied by the graphic method. Excellent pulse curves may be obtained by placing a sphygmograph upon the aortic tube.

I first described the circulation scheme in 'The Introduction to Physiology,' January, 1900. Its use during two years by large numbers of students in the Harvard Medical School has suggested certain changes which enable the apparatus to be more quickly put together. In making these changes I have been much helped by the criticism of Mr. F. H. Pratt, Dr. W. B. Cannon and others of my associates.* The accompanying figures show the most recent form of the apparatus.

### III. THE MOIST CHAMBER.

The moist chamber, shown in Fig. 4, provides for the study of the electrical properties of nerve and muscle under conditions that prevent the stimulation caused by drying. It consists of a porcelain plate which bears near the margin a shallow groove. In this groove rests a glass shade which for the sake of clearness has been omitted from Fig. 4. To the porcelain plate is screwed a rod, by which the plate may be supported on a stand. Within the glass shade a right-angled rod carries a small clamp, composed of a split screw on which moves a nut, by means of which the femur of a nerve muscle preparation may be firmly grasped. The holder for the split screw is arranged to permit of motion in all directions. The right-angled rod also carries two or more unpolarizable electrodes. Each of these is

* To Mr. Pratt's skilful hand I am indebted for the drawings from which Fig. 2 and Fig. 3 were made.

borne by a spring clip. On compressing its projecting ends the clip no longer presses against the rod, but may be moved from side to side or revolved upon its axis. The electrodes are made of potter's clay, skilfully fired, and are unglazed except where they are grasped by the spring clip. They have the shape of a boot. By turning the leg of the boot in the clip the foot may be brought as near the foot of the neighboring electrode as may be desired. On placing the boot in normal saline solution the porous clay rapidly absorbs the indifferent liquid. The hollow leg of the boot is then half filled with saturated solution of zinc sulphate and

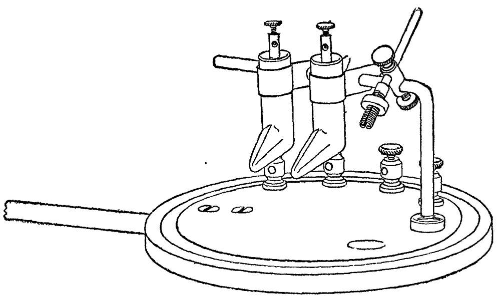

FIG. 4. The moist chamber, with spring clips and unpolarizable boot electrodes.

placed in the clip. A thick wire of amalgamated zinc, provided at one end with a hole in which a connecting wire may be fastened with a set-screw, is placed in the leg of the boot, and the other end of the connecting wire brought to one of the four binding posts shown in Fig. 4. These four posts are in electrical connection with four other posts beneath the porcelain plate. The boot electrodes are unpolarizable. They serve equally well for leading off the nerve or muscle current to the electrometer and for stimulation. They are easily cleaned and are far more convenient than the electrodes of glass and clay or plaster of Paris.

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September 20, 1901.

## *ANDREW ELLICOTT DOUGLASS.*

ANDREW ELLICOTT DOUGLASS died on September 30 in his eighty-second year. Anthropological science has thus lost a sincere friend. Mr. Douglass was born at West Point, New York, on November 18, 1819. He was the son of Major David Bates Douglass, and his mother was a daughter of Andrew Ellicott, professor of mathematics at West Point.

Mr. Douglass graduated from Kenyon College in 1838 and received the degree of A.M. in 1841. On completing his undergraduate course he engaged in business, being connected with the firm afterwards known as the Hazard Powder Company. In 1867 he became president of the company and retired nine years later from a successful business career.

Since 1876 Mr. Douglass devoted much of his time to the study of the Indian artifacts of the United States. He spent ten winters cruising along the Floridian coast, locating over fifty Indian mounds, many of which he excavated. For his study Mr. Douglass brought together an excellent library relating to American archeology and made a synoptical collection of over 22,000 specimens, which latter he presented to the American Museum of Natural History during the present year. This collection of implements is arranged in various special classes irrespective of geographical distribution with the purpose of solving the theory of their use. Mr. Douglass believed, however, in the geographical method of arrangement, but that both methods were necessary. A series of over a thousand hematite objects in the collection constitutes what is perhaps a unique feature. The collection is most carefully catalogued and cross-referenced as might be expected by those who knew Mr. Douglass's painstaking business method.

Mr. Douglass was a member of the Metropolitan Museum of Art and a patron of